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If NO period for reply is specified above, the maximum statutory period will apply and will expire 6 MONTHS from the mailing date of this communication.



### DETAILED ACTION

1. Claims 21-22 are new. Claims 1, 16, and 17 are amended. Claims 2, 6-13, and 15 are in their original form. And claims 3-5, 14, and 18-20 were previously presented. Therefore, claims 1-22 are pending in this office action.

#### *Claim Rejections - 35 USC § 102*

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

2. Claims 1-3, 6, 8-9, 12-13, and 16-22 are rejected under 35 U.S.C. 102(b) as being anticipated by non-patent literature titled “Diffusion Tree Restructuring for Indirect Reference Counting” issued to Dr. Peter Dickman (hereinafter “Dickman”).

#### **Claim 1:**

Dickman discloses a method for determining if an object in a memory resource in a computer system is a candidate for garbage collection, comprising:

for each of a plurality of objects in the memory resource, maintaining a reference count based on a number of objects pointing thereto (*Dickman: page 2, column 1, lines 9-14*), and maintaining a depth value based on a distance from a global data object in a reference chain (*Dickman: page 6, column 2, lines 18-20*), the step of maintaining a depth value further including at least keeping an existing depth value associated with an object when a new link is added from another object to the object if the existing depth value associated with the object is a valid depth

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value (*Dickman: page 6, column 2, lines 18-20 and page 6, column 2, lines 30-41; The references clearly show maintaining a depth value and keeping a current depth value after a new link is created.*);

identifying, based on the associated reference count and depth value, which of the plurality of objects are processed to determine whether or not they are garbage (*Dickman: page 9, column 1, lines 48-55 and page 9, column 2, lines 8-14; Dickman's invention clearly discloses the use of a reference count and depth value in order to determine if an item is garbage, which aids the computer in actually collecting the garbage.*);

wherein each of the plurality of objects can be pointed to by one or more other objects and wherein each of the plurality of objects can be part of, and have different positions in, different reference chains such that the reference count and depth value change as the other objects that point to each of the plurality of objects change (*Dickman: page 2, column 1, lines 9-14 and page 6, column 2, lines 18-20; The Applicant's claimed invention simply recites reference counting garbage collecting with the addition of a depth counter. Reference counting garbage collection is well known in the art. And note that the Dickman reference clearly discloses maintaining both a reference count and depth value to aid in the collection of garbage.*).

**Claim 2:**

Dickman discloses all the elements of claim 1, as noted above, and Dickman further discloses wherein:

for each object, the depth value is maintained by providing a depth value in metadata associated with the object (*Dickman: page 6, column 2, lines 22-24; The Dickman reference clearly points out that a depth value is annotated for each object. No matter where the depth value is stored, it must be stored in some*

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*form of metadata because the depth value is itself metadata. The depth value is data about the object data. So where the depth value is stored it must be stored with metadata because the depth value itself is metadata.).*

**Claim 3:**

Dickman discloses all the elements of claim 1, as noted above, and Dickman further discloses wherein:

a first of the objects is identified for processing when it is determined that a second of the objects previously pointing thereto is no longer pointing thereto (*Dickman: page 2, column 1, lines 17-19*), and the depth value of the second object is one less than the depth value of the first object (*Dickman: page 6, column 2, lines 18-20*).

**Claim 6:**

Dickman discloses all the elements of claim 1, as noted above, and Dickman further discloses wherein:

the distance for each of the plurality of objects is based on a number of objects linking the each of the plurality of objects to the global data object (*Dickman: page 6, column 2, lines 18-20 and Fig. 8i*).

**Claim 8:**

Dickman discloses all the elements of claim 1, as noted above, and Dickman further discloses method comprising:

initializing the depth value of a new object created at runtime to one or more than the depth value of an object that points to the new object and links the new object to the global data object (*Dickman: page 6, column 2, lines 18-20*).

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**Claim 9:**

Dickman discloses all the elements of claim 1, as noted above, and Dickman further discloses wherein:

when a particular one of the objects that is processed is determined to be garbage, its associated portion of the memory resource is made available for re-allocation (*Dickman: page 2, column 1, lines 17-19; When memory is re-claimed in by a garbage collection process, it is re-allocated.*).

**Claim 12:**

Dickman discloses all the elements of claim 10, as noted above, and Dickman further discloses wherein:

the particular object is determined to be non-garbage when it is accessible to outside objects (*Dickman: page 2, column 1, lines 17-19; An object is only determined to be garbage when it is not accessible to outside objects through reference pointers. Therefore, if the object is accessible to outside objects through reference pointers, then the object is not garbage.*).

**Claim 13:**

Dickman discloses all the elements of claim 1, as noted above, and Dickman further discloses wherein:

when a new link is created from a first object of the plurality of objects to a second object of the plurality of objects, and the first object has a valid depth value but the second object does not have a valid depth value, the depth value of the second object is initialized to one more than the depth value of the first object (*Dickman: page 6, column 2, lines 18-20*).

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**Claim 16:**

Claim 16 is a computer program product claim corresponding to method claim 1 and is rejected under the same reasons set forth in the rejection of claim 1.

**Claim 17:**

Claim 17 is a computer system claim corresponding to method claim 1 and is rejected under the same reasons set forth in the rejection of claim 1.

**Claim 18:**

Dickman discloses all the elements of claim 1, and Dickman further discloses wherein the depth value ranges from a first value to a predetermined maximum value and when a depth value associated with a first object reaches the predetermined maximum value, a depth value associated with a second object that links from the first object is wrapped around to the first value (*Dickman: page 2, column 1, lines 45-51*).

**Claim 19:**

Claim 19 is rejected under the same reasons set forth in the rejection of claim 18.

**Claim 20:**

Claim 20 is rejected under the same reasons set forth in the rejection of claim 18.

**Claim 21:**

Dickman discloses all the elements of claim 1, as noted above, and Dickman further discloses wherein:

a first of the objects is identified for processing when it is determined that a second of the objects previously pointing thereto is no longer pointing thereto, and the depth value of the first object is not known (*Dickman: page 2, column 1, lines 17-19*).

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**Claim 22:**

Dickman discloses all the elements of claim 1, as noted above, and Dickman further discloses a method including:

identifying a first of the objects as not being garbage when it is determined that a second of the objects previously pointing thereto is no longer pointing thereto (*Dickman: page 2, column 1, lines 17-19*), if the depth value of the first object is known and the depth value of the second object is not one less than the depth value of the first object (*Dickman: page 6, column 2, lines 18-20*).

***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. Claims 4-5 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dickman and further in view of the admitted prior art of U.S. Patent Application Publication Number 2002/0087590 issued to David Francis Bacon et al. (hereinafter "Bacon Prior Art").

**Claim 4:**

Dickman discloses all the elements of claim 3, as noted above. The Examiner believes that all elements of claim 4 are implicitly disclosed in the Dickman reference because the Dickman reference clearly teaches reference counting garbage collection. But, the Dickman reference does not explicitly disclose wherein: the second object is no longer pointing to the first object because the second object was destroyed.

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However, Bacon Prior Art discloses wherein: the second object is no longer pointing to the first object because the second object was destroyed (*Bacon Prior Art: paragraph [0013], lines 9-12; This reference shows a node being removed (destroyed). A node that is removed (destroyed) can no longer point to any other objects. It is obvious, and possibly inherent, that if the second object is destroyed that it is no longer point to a first object.*). It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of Dickman with the teachings of Bacon Prior Art noted above. The skilled artisan would have been motivated to improve the teachings of Dickman per the above such that a system will easily recognize that a given subgraph is garbage (*Bacon Prior Art: paragraph [0013], lines 9-12*).

**Claim 5:**

Dickman discloses all the elements of claim 3, as noted above. The Examiner believes that all elements of claim 5 are implicitly disclosed in the Dickman reference because the Dickman reference clearly teaches reference counting garbage collection. But the Dickman reference fails to explicitly disclose wherein the second object is no longer pointing to the first object because the second object was reset to point to another.

However, Bacon Prior Art discloses wherein the second object is no longer pointing to the first object because the second object was reset to point to another (*Bacon Prior Art: paragraph [0012], lines 1-4; This reference shows tracking a reference count for an object. As a computer program executes, pointers are setting and resetting constantly to reflect changes in the program. It is just a matter of time before a given object will no longer point to another object. The reference counting algorithm disclosed by Bacon Prior Art then identifies an item as garbage when no more reference pointers point to a particular object*). It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the

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teachings of Dickman with the teachings of Bacon Prior Art noted above. The skilled artisan would have been motivated to improve the teachings of Dickman per the above such that a reference count for each node is efficiently tracked upon the changing of an object reference pointer (*Bacon Prior Art: paragraph [0012], lines 1-4*).

4. Claim 7 is rejected under 35 U.S.C. 103(a) as being unpatentable over Dickman and further in view of U.S. Patent Application Publication Number 2002/0087590 issued to David Francis Bacon et al. (hereinafter "Bacon").

**Claim 7:**

Dickman discloses all the elements of claim 6, as noted above, and But Dickman does not explicitly disclose wherein: the objects processed to determine whether or not they are garbage are processed by a loop detection mechanism for a reference counting garbage collector.

However, Bacon discloses wherein: the objects processed to determine whether or not they are garbage are processed by a loop detection mechanism for a reference counting garbage collector (*Bacon: paragraph [0019], lines 1-5*). It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of Dickman with the teachings of Bacon noted above. The skilled artisan would have been motivated to improve the teachings of Dickman per the above such that cycles in a reference counting garbage collecting method could be detected (*Bacon: paragraph [0019], lines 1-5*).

5. Claims 10-11 and 14-15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dickman and further in view of U.S. Patent Number 6,338,159 issued to William Preston Alexander, III et al. (hereinafter "Alexander").

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**Claim 10:**

Dickman discloses all the elements of claim 1, as noted above, but Dickman does not explicitly disclose wherein: when a particular one of the objects that is processed is determined to be non-garbage, its depth value, and the depth values of other ones of the objects that are pointed to by the particular object and linked to the global data object thereby, are reset.

However, Alexander discloses wherein: when a particular one of the objects that is processed is determined to be non-garbage, its depth value, and the depth values of other ones of the objects that are pointed to by the particular object and linked to the global data object thereby, are reset (*Alexander: column 5, lines 24-27 and Fig. 5; By resetting the depth (level) value of the root object in Fig. 5, the depth value of all the objects pointed to by that object would also reset. This is because the root would initialize to zero and the nodes the root points to will have a level (or depth) value that counts up from zero.*). It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of Dickman with the teachings of Alexander noted above. The skilled artisan would have been motivated to improve the teachings of Dickman per the above such that the level (or depth) value generated by tracing could be used in the memory allocation and deallocation process (*Alexander: column 2, lines 42-43*).

**Claim 11:**

The combination of Dickman and Alexander discloses all the elements of claim 10, as noted above, and Alexander further discloses wherein:

the depth values of objects that are pointed to by the other ones of the objects whose depth values are reset, and linked to the global data object thereby, are also reset (*Alexander: column 5, lines 24-27 and Fig. 5; Claim 11 is rejected under the same reasons set forth in claim 10.*).

**Claim 14:**

Dickman discloses all the elements of claim 1, as noted above. The Examiner believes that all elements of claim 14 are implicitly disclosed in the Dickman reference because the Dickman reference clearly teaches a reference counting garbage collection algorithm, which maintains depth values. These depth values would have to have some initial value. But, the Dickman reference does not explicitly disclose a method, which comprises initializing a depth value of the global object to a valid depth value.

However, Alexander discloses a method, which comprises initializing a depth value of the global object to a valid depth value (*Alexander: column 5, lines 24-27 and Fig. 5; Both of these references display initializing the global object (root) to a depth (level) of zero.*). It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of Dickman with the teachings of Alexander noted above. The skilled artisan would have been motivated to improve the teachings of Dickman per the above such that the level (or depth) value generated by tracing could be used in the memory allocation and deallocation process (*Alexander: column 2, lines 42-43*).

**Claim 15:**

Dickman discloses all the elements of claim 1, as noted above, but Dickman does not explicitly disclose a method, which comprises initializing depth values of the plurality of objects to a specified value.

However, Alexander discloses a method, which comprises initializing depth values of the plurality of objects to a specified value (*Alexander: column 5, lines 24-27 and Fig. 5; These references show that the depth value of objects are initialized to one more than the depth value of the object linked to*

it.). It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of Dickman with the teachings of Alexander noted above. The skilled artisan would have been motivated to improve the teachings of Dickman per the above such that the level (or depth) value generated by tracing could be used in the memory allocation and deallocation process (*Alexander: column 2, lines 42-43*).

### ***Response to Arguments***

#### **Applicant Argues:**

Claims 1-3, 6, 8-9, 12-13, and 16-20 were rejected under 35 U.S.C. §102(e) as allegedly being anticipated by "Diffusion Tree Restructuring for Indirect Reference Counting" (Dickman). Applicant respectfully traverses the rejection. First, applicant believes that Dickman does not qualify as prior art 35 U.S.C. §102(e). Condition for patentability under 102(e) refers to published applications or granted patents. Dickman as the Office Action states is a non-patent literature, and therefore does not qualify as prior art under that section.

#### **Examiner Responds:**

Claims 1-3, 6, 8-9, 12-13, and 16-20 were originally rejected under 35 U.S.C. 102(b) as being anticipated by "Diffusion Tree Restructuring for Indirect Reference Counting" (Dickman). This is clearly shown by the fact that the text for 35 U.S.C. 102(b) was copied into the office action. Note that the Dickman article was published in January 2001 and the Applicant's earliest filing date is July 15, 2003. The '35 U.S.C. 102(e)' which appeared in the Examiner's office action was simply a typographical error. The Examiner apologizes for any confusion this may have caused. Currently Claims 1-3, 6, 8-9, 12-13, and 16-22 remain rejected under 35 U.S.C. 102(b).

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**Applicant Argues:**

In addition, applicant believes that the rejection over Dickman is improper because Dickman fails to disclose or suggest every element claimed at least in independent claims 1, 16, and 17. For example, Dickman does not disclose or suggest at least "identifying, based on the associated reference count and depth value, which of the plurality of objects are processed to determine whether or not they are garbage" as recited in independent claims 1, 16, and 17.

However, while Dickman appears to use Depth counters in reducing or reordering the objects in a tree, Dickman does not disclose or suggest using a depth counter to determine whether an object is to be processed as garbage.

**Examiner Responds:**

Examiner is not persuaded. The Examiner maintains that the Dickman reference discloses "identifying, based on the associated reference count and depth value, which of the plurality of objects are processed to determine whether or not they are garbage" (*Dickman: page 9, column 1, lines 48-55 and page 9, column 2, lines 8-14*).

It appears that the Applicant is simply arguing that the intended use of the reference count and depth count in the Applicant's invention is different than the intended use of the reference count and depth count in the Dickman reference.

In response to applicant's argument that Dickman does not disclose or suggest using a depth counter to determine whether an object is to be processed as garbage, a recitation of the intended use of the claimed invention must result in a structural difference between the claimed invention and the prior art in order to patentably distinguish the claimed invention from the prior art. If the prior art structure is capable of performing the intended use, then it meets the claim.

It is abundantly clear that the Dickman reference is capable of performing the same intended use set forth by the Applicant since the Dickman reference also discloses augmenting a

simple reference counting garbage-collecting system to also include a depth counter. Therefore, the rejections given under 35 U.S.C. 102(b) are upheld.

**Applicant Argues:**

In addition, while the above reasons suffices to distinguish independent claims 1, 16, and 17 from Dickman, applicant believes that Dickman also does not disclose or suggest at least “keeping an existing depth value associated with an object when a new link is added from another object to the object if the existing depth value associated with the object is a valid depth value” because Dickman does not have a notion of what is valid or invalid depth value because whether a depth value is valid or invalid is inconsequential to Dickman’s purposes.

**Examiner Responds:**

Examiner is not persuaded. Dickman clearly discloses “keeping an existing depth value associated with an object when a new link is added from another object to the object if the existing depth value associated with the object is a valid depth value”

*(Dickman: page 6, column 2, lines 18-20 and page 6, column 2, lines 30-41).*

If the depth value is valid after a new link is created, the sub-root node’s depth will not be updated (i.e., it will be kept), however, if the depth value is not valid, the sub-root node’s depth will be updated.

Since it is clear that Dickman discloses all the elements of the Applicant’s claimed invention, the rejections given under 35 U.S.C. 102(b) are upheld.

**Applicant Argues:**

Contrarily, page 2, column 1, lines 17-19 appears to provide some background data about the special problems that distributed reference counting collectors face; page 6, column 2, lines 18-20 appears to describe that Dickman’s algorithm requires a depth counter and some basic requirements about its semantics. Dickman in those passages (or anywhere else), however, does not disclose or suggest to identify an object for garbage processing if it is determined that a second of the objects previously pointing thereto is no longer pointing thereto, and the depth value of the second object is one less than the depth

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value of the first object (or one less than the depth value of the first object modulo a maximum depth value, when depth value wrapping is involved). Therefore, claim 3 is further not anticipated by Dickman for at least this additional reason.

**Examiner Responds:**

Examiner is not persuaded. The Examiner has clearly pointed out each of the Applicant's claimed limitations in the preceding office action. It is clear that the Dickman reference alters a reference counting garbage collector to also consult a depth value in the decision making process of determining what objects are in fact garbage (*Dickman: page 2, column 1 and page 6 column 2 and page 9, column 1, lines 48-55 and page 9, column 2, lines 8-14*).

In response to applicant's argument that Dickman does not disclose or suggest using a depth counter to identify an object for garbage processing if it is determined that a second of the objects previously pointing thereto is no longer pointing thereto, and the depth value of the second object is one less than the depth value of the first object, a recitation of the intended use of the claimed invention must result in a structural difference between the claimed invention and the prior art in order to patentably distinguish the claimed invention from the prior art. If the prior art structure is capable of performing the intended use, then it meets the claim.

It is abundantly clear that the Dickman reference is capable of performing the same intended use set forth by the Applicant since the Dickman reference also discloses augmenting a simple reference counting garbage-collecting system to also include a depth counter. Therefore, the rejections given under 35 U.S.C. 102(b) are upheld.

***Conclusion***

**THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

***Contact Information***

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Patrick A. Darno whose telephone number is (571) 272-0788. The examiner can normally be reached on Monday - Friday, 10:00 am - 6:30 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Don Wong can be reached on (571) 272-1834. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

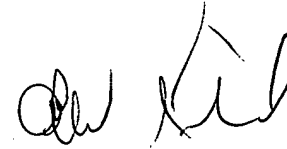
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PAD

Patrick A. Darno  
Examiner  
Art Unit 2163



ALFORD KINDRED  
PRIMARY EXAMINER